

## Lignin chemistry as natural starting platform to design innovative replacing multifunctional ingredients: a green chemistry approach

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The lignocellulosic biomass is considered the most promising natural source for the replacing of obsolete synthetic component with high environmental impact commonly used in different manufacturing fields. Lignin is the most abundant aromatic biopolymers on the earth representing up to 50% in weight of lignocellulosic biomass usually produced in large amount as by product mainly from biorefinery and pulp industries. The interesting chemical-physical properties of lignin make this biopolymer a prominent choice as replacement ingredient in several application fields thank to the strong UV-absorbance/UV-stability and the radical scavenging activity. Furthermore, under specific conditions lignin is able to undergo nanostructuring, passing from the amorphous to the nano spherical shape without chemical modifications, thus obtaining lignin nanoparticles. In the nanostructured form, lignin showed improved properties and new features such as the presence of an empty cavity which further extending its application fields. In this scenario, lignin nanoparticles have been used to create innovative and multifunctional ingredients in the cosmetic field in order to replace common obsolete synthetic UV filters known for their environmental and human health impact. Furthermore, thanks to the knowledge on enzymatic catalysis gained by Gentoxchem, lignin nanoparticles were used as cores for the in-situ biosynthesis of melanin. This has allowed to produce natural pigments able to replacing current inks which are often composed of heavy metals that are toxic to the environment and humans.